United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-95/036
March 1995

EPA

Pollution Prevention Case Studies Compendium

2nd Edition

EPA/600/R-95/036
March 1995

POLLUTION PREVENTION
CASE STUDIES COMPENDIUM
2nd Edition

by

Diana Kirk and Franklin Alvarez
Waste Minimization, Destruction
and Disposal Research Division
Risk Reduction Engineering Laboratory
Cincinnati, Ohio 45268

Project Officers:

Diana Kirk and Franklin Alvarez
Waste Minimization, Destruction
and Disposal Research Division
Risk Reduction Engineering Laboratory
Cincinnati, Ohio 45268

RISK REDUCTION ENGINEERING LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

DISCLAIMER

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency. It has been subjected to the Agency's peer and administrative review, and it has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing research, development and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

This report is a second collection of summaries of pollution prevention demonstrations, assessments, and research projects conducted by the Pollution Prevention Research Branch. The Branch is charged with defining, evaluating, and advancing the technology for the implementation of a national pollution prevention program. It also provides technical assistance to other sections of EPA for the purpose of reducing or eliminating pollution hazards.

The information contained here will serve as a reference work and technology transfer vehicle to disseminate research results and promote the implementation of pollution prevention activities.

E. Timothy Oppelt, Director
Risk Reduction Engineering Laboratory

ABSTRACT

The Pollution Prevention Research Program encourages the development and adoption of processing technologies and products in the United States that will lead to reducing the aggregate generation rates for pollutants entering the various environmental media. It includes projects to improve the understanding of environmental problems that might be amenable to pollution prevention approaches, and projects that demonstrate innovative pollution prevention approaches and technologies. Pollution Prevention Research supports studies and research and demonstration projects that are designed to further the utilization of source reduction and to a lesser degree recycling as preferable environmental improvement strategies. Projects within the program are supported through in-house activities, contracts with outside organizations, and cooperative agreements with universities and other government agencies.

The Risk Reduction Engineering Laboratory (RREL) serves as the lead organization within the EPA's Office of Research and Development for research related to pollution prevention. Spearheading pollution prevention research within RREL is the Pollution Prevention Research Branch (PPRB) of the Waste Minimization Destruction and Disposal Research Division. Efforts cover all sectors identified in EPA's Pollution Prevention Strategy (January, 1991), i.e., manufacturing, agriculture, energy and transportation, municipal water and wastewater, federal facilities and municipal solid waste. The program also contains a technology transfer element for incorporating results from other's research and for disseminating the results of the program's efforts.

As a major part of the effort to disseminate the results of its research, PPRB has produced a second compilation of case studies. These studies are the culmination of some of the major current research efforts being conducted in the area of pollution prevention. It is a compilation of summaries of pollution prevention demonstrations, assessments and research projects conducted within the Branch. We hope that this compendium will facilitate the development and adoption of pollution prevention techniques throughout the United States and other countries.

This report covers a period of May 1992 to May 1994 and work was completed as of February 1995.

CONTENTS

ACKNOWLEDGMENTS

This report was prepared by Mr. Franklin Alvarez and Ms. Diana Kirk, EPA's Project Officers in the Pollution Prevention Research Branch of the Risk Reduction Engineering Laboratory, Cincinnati, Ohio. Appreciation is given to the large number of contributors to this report. Contributions were made by USEPA's Office of Research and Development, various Federal Departments, state pollution prevention and research organizations, and members of industry.

INTRODUCTION

As a major part of the effort to disseminate the results of its research, the Pollution Prevention Research Branch has produced this compilation of case studies. These studies are the culmination of some of the major current research efforts being conducted in the area of pollution prevention. It is a compilation of summaries of pollution prevention demonstrations, assessments and research projects conducted within the Branch.

The compendium is separated into three sections, featuring three of the Branch's key programs. The Waste Reduction Innovative Technology Evaluation (WRITE) Program is a technology demonstration program conducted in cooperation with six states and one local government. The focus of the research is to perform technical and economic evaluations of pollution prevention technologies. The Waste Reduction Evaluations at Federal Sites (WREAFS) Program focuses on performing waste minimization assessments at various Federal facilities. The University-Based Assessments Program targets small and medium-sized businesses in its assessment program. This program utilizes Waste Minimization Assessment Centers in Colorado, Kentucky and Tennessee to conduct waste minimization assessments for businesses which lack pollution prevention expertise. The two assessment programs follow the procedures outlined in the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988)

An overview of each program is provided at the beginning of each section of the compendium. The case studies are cross referenced according to key words in an index at the end of the compendium. The Information is also provided on the EPA Project Officer and the Principal Investigator conducting the research. Case studies of individual EPA project summaries and environmental research briefs may be available from EPA's Center for Environmental Research Information (CERI): U.S. Environmental Protection Agency, Center for Environmental Research Information, 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. Information on obtaining project summaries for other reports is available by contacting the EPA Project Officer referenced.

SECTION 1

WASTE REDUCTION INNOVATIVE TECHNOLOGY EVALUATION PROGRAM

(WRITE)

Overview

The Waste Reduction Innovative Technology Evaluation (WRITE) Program is a research demonstration program designed to evaluate the use of innovative engineering and scientific technologies to reduce the volume and/or toxicity of wastes produced from the manufacture, processing, and use of materials. It encourages the interaction of government and industry in the demonstration and evaluation of available innovative production and recycling options for reducing waste generation.

The objectives of the WRITE Program are:

(1) To establish reliable performance and cost information on pollution prevention techniques by conducting evaluations or demonstrations of the more promising innovative technologies.

(2) To accomplish an early introduction of waste reduction techniques into broad commercial practice.

(3) To encourage active participation of small and medium-sized companies in evaluating and adopting pollution prevention concepts by providing support to these companies through State and local government agencies.

(4) To encourage the transfer of knowledge and technology concerning pollution prevention practices between large, medium-sized, and small industries.

(5) To provide solutions to important chemical-, wastestream-, and industry-specific pollution prevention research needs.

Under the WRITE Program, EPA and seven cooperating state and county governments (California, Connecticut, Illinois, Minnesota, New Jersey, Washington, and Erie County, New York) evaluate and demonstrate the engineering and economic feasibility of selected waste reducing technologies in a manufacturing or fully operational setting.

Research efforts under the WRITE Program focus primarily on source reduction and the recycling and reuse of waste materials. The WRITE Program has completed, ongoing and/or future technology evaluations in the areas of: on-site solvent recovery, paint mixing/stripping, plating solution recovery, solvent paint remover substitiutes, water-based inks as substitutes for solvent based inks, cutting fluid recycling, biodegradable solvents, CFC replacement/recovery, fluid sorbent recycling, vacuum distillation, ion exchange, ultrafiltration and others.

EPA acknowledges and appreciates the cooperation of the following organizations in the administration of the WRITE Program:

California:	California Department of Health Services (DHS)
Connecticut:	Connecticut Hazardous Waste Management Service (CHWMS)
Illinois:	Illinois Hazardous Waste Research and Information Center (IHWRIC)
Minnesota:	Minnesota Technical Assistance Program (MnTAP)
New Jersey:	New Jersey Department of Environmental Protection (NJDEP)
Washington:	Washington Department of Ecology
New York:	Erie County Department of Environment and Planning, Division of Environmental Erie County, Compliance Services

TITLE: On-Site Solvent Recovery

INTRODUCTION: This study evaluated the product quality, waste reduction/pollution prevention and economic aspects of three technologies for onsite solvent recovery: atmospheric batch distillation, vacuum heat-pump distillation, and low emission vapor degreasing (LEVD). A comparison of the three units was not the objective of the study. Rather, the suitability of each technology to its respective application was examined.

BACKGROUND INFORMATION: This study was performed under the U.S. Environmental Protection Agency's (EPA's) Waste Reduction and Innovative Technology Evaluation (WRITE) Program. It was a cooperative effort between EPA's Risk Reduction Engineering Laboratory (RREL) and the Washington Department of Ecology. The objective of the WRITE Program is to evaluate in a typical workplace environment, examples of prototype or innovative commercial technologies that have a potential for source reduction or recycling.

TECHNOLOGY DESCRIPTION: Atmospheric distillation is the simplest technology available to recover liquid spent solvents. The unit can distill up to 55 gal/batch. Some units can be modified to operate under vacuum for higher boiling solvents (>135°C). The unit was tested on spent methyl ethyl ketone. The distillation residue, often a relatively small fraction of the spent solvent is disposed of as hazardous waste. The vacuum unit is configured similar to a conventional vacuum distillation system. The pump functions as a heat pump, which generates a vacuum for distillation and compresses vapors for condensation. The vacuum unit was tested on spent methylene chloride. The product quality objective for the two liquid distillation units was to show that the recycled solvent was of sufficient quality for reuse and that the recycled spent solvent volume was substantially reduced. Both methyl ethyl ketone and methylene chloride are hazardous chemicals listed on the Toxics Releases Inventory (TRI). These solvents also are on EPA's list of 17 chemicals targeted for 33% reduction by 1992 and 50% reduction by 1995.

Previous studies (Batelle 1992) on conventional open-top vapor degreasers have shown that a large part of the solvent (more than 90% in some cases) is lost through air emissions. These losses can be considerable even though vapor degreasers are required to have primary cooling coils (tapwater cooled) and a certain freeboard height. Air emissions are a concern for metal finishers because many solvents used in vapor degreasing have been targeted by EPA in the 33/50 Program.

TECHNOLOGY EVALUATION: The two distillation units demonstrated that through recycling, large volumes of spent solvent waste were reduced to small volumes of distillation residue, which is disposed of as RCRA hazardous waste. Also, the measured parameters showed a significant improvement from spent to recycled samples.

The main benefit of the low-emission vapor degreasing (LEVD) process is that it is a completely enclosed, airtight unit. Testing was conducted on the LEVD using perchloroethylene (PCE) solvent. Test runs were conducted on machined steel parts with and without cutting oil on the parts. Adding oil to the parts did not greatly affect the total cycle time, but the workload mass did. The LEVD reduces air emissions by more than 99% compared to air emissions from the typical conventional open-top vapor degreaser.

ECONOMIC EVALUATION: Compared to disposal, the atmospheric and vacuum distillation units reduced operating costs significantly. The estimated payback period for the units was found to be less than 2 years. The low emissions vapor degreaser is a slightly higher capital investment (with a payback period of approximately 10 years), but it eliminated the need for other potentially expensive auxiliary equipment that conventional vapor degreasers would require to meet comparable pollution prevention objectives.

CONCLUSION: All three technologies evaluated demonstrated good potential for pollution prevention/waste reduction. The two solvent distillation technologies reduced large volumes of hazardous solvent to a few gallons of distillation residue and produced a reusable recycled product. Onsite recovery is preferable because of the reduced transportation hazard. The largest single use for solvents in the United States is for vapor degreasing. The LEVD reduced air emissions significantly compared to emissions from a conventional vapor degreaser. Payback periods for the two distillation technologies are less than 2 years. The LEVD payback period is approximately 10 years.

PRINCIPAL INVESTIGATOR: Arun R. Gavaskar
Batelle
Columbus, Ohio 43201

EPA PROJECT MANAGER: Ivars Licis
US EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7718

KEY WORDS: distillation, atmospheric batch distillation; vacuum heat-pump distillation; low emission vapor degreasing; vapor degreasing solvents; methyl ethyl ketone; methylene chloride; perchloroethylene; on-site recovery; air emissions

TITLE: Ink and Cleaner Waste Reduction Evaluation for Flexographic Printers

INTRODUCTION: Wastes are generated at most stages of the printing process. Ink wastes result when the reservoir, the various rollers, and the printing plate are cleaned at the end of a run. Excess ink in the reservoir can be collected for reuse, but the other ink quantities removed during cleaning generally remain as waste. Exceptional amounts of waste labels are generated during the production of multicolor labels because of color registration difficulties. Also, most printing processes begin with a photographic negative. Developing the negative generates a number of chemical wastes that usually require special treatment for either recycling or disposal. In nearly every step of the printing process some volatile chemicals are released into the air. These volatiles can range from water to various alcohols, plastic thickeners, homogenizers, and chemical diluents. In addition to volatile losses associated with inks, adhesive and solvent molecules evaporate from the adhesive-coated label surfaces. Cleaning agents used on the press will also evaporate into the air.

BACKGROUND INFORMATION: This project originated with the Waste Reduction Innovative Technology Evaluation (WRITE) Program and was designed to 1) quantitatively compare the volume and toxicity of any waste generated during printing and released as gaseous, liquid, or solid waste before and after switching to water-based inks and a detergent cleaner and 2) determine the economic effect of modifying a traditional printing technology. The participating firm was a narrow-web flexographic printer. MPI Label Systems, Inc., of University Park, Illinois. Several years ago, management directed the company's eight plants to eliminate the use of all hazardous and toxic materials. The decision forced each plant to substitute water-based inks for alcohol-based inks and to change from alcohol solvent cleaning agents to aqueous-type cleaning agents.

TECHNOLOGY DESCRIPTION: Laboratory measurement of solvent loss by evaporation for each ink was used to estimate the percent volatiles. By comparison, water-based inks contain less volatiles than do alcohol-based inks, plus some of the water (24%) is bound to the resins and does not evaporate on drying. The detergent cleaner as compared to the solvent cleaner was mostly water. The amount of ink and other materials disposed of as liquid waste was determined gravimetrically.

TECHNOLOGY EVALUATION: The proportion of alcohol-based ink that evaporated was 48%, compared with 56%-62% for water-based inks. The press operators at MPI estimated that about the same total amount of either ink is required for a job. Thus, the emission analysis is conservative for the alcohol-based ink. A toxicity reduction evaluation was calculated for four printing scenarios. For estimated emissions to the air, alcohol-based inks and cleaners had relative toxicities about 10 times higher than those for the water-based emissions. Before MPI began using water-based inks and detergent cleaner, it disposed solvent-based waste ink as a hazardous waste. Although the total amount of liquid solvent-based waste was manifested in a year, MPI considered this information proprietary. For this reason, and because MPI no longer uses solvent-based ink and cleaner, it was not possible to measure the amount of alcohol-based ink and cleaner wastes. In their experience, the same amount was generated, but water-based inks aren't considered hazardous.

ECONOMIC EVALUATION: Annual waste disposal and handling account for at least a savings of $15,000. The facility saves about $500 each year because of lowered insurance premium based on improved working conditions. Savings because of new wiping materials equals about $1,000 annually. Therefore, the total annual savings is $16,500.

CONCLUSIONS: The results from the change to water-based ink and cleaner are beneficial to MPI Label Systems. Solvent emissions to the plant air have been reduced. Toxicity of these emissions has gone from potentially hazardous to nonhazardous. And finally, solid waste generated and destined to landfills has been reduced in volume and is no longer classified as hazardous. In addition, these changes did not incur capital costs nor increased operational expenses. Rather, the plant saves a significant amount with reduced waste disposal, insurance, and cleaning material costs.

PRINCIPAL INVESTIGATOR: Gary D. Miller
Hazardous Waste Research
and Information Center
Champaign, Illinois 61820

Michael J. Plewa
University of Illinois
Urbana-Champaign Institute for
Environmental Studies
Champaign, Illinois 61820

EPA PROJECT MANAGER: Paul M. Randall
US EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7673

KEY WORDS: ink wastes; waste labels; printing processes; volatiles; alcohols; plastic thickeners; cleaning agents; water based inks; alcohol-based inks; detergent cleaner

TITLE: Replacement of Hazardous Material in Wide Web Flexographic Printing Process

INTRODUCTION: This study evaluated the effectiveness and applicability of ink substitutions to reduce waste in a wide web (greater than 16 in. wide) flexographic printing process. This project was completed under the Erie County/EPA Waste Reduction Innovative Technology Evaluation (WRITE) Program as a joint effort by Lustreprint Company (industrial participant). Lustreprint was required to submit to the New York State Department of Environment Conservation (NYSDEC) a monthly report describing VOC emissions from the plant as a result of operations. In 1974, the NYSDEC approved a permit for air emissions from Lustreprint's two printing presses. When a 3 shift, 7 day-a-week work schedule was implemented in 1989, the total emissions exceeded the baseline criteria of 100 tons/yr of VOCs.

TECHNOLOGY DESCRIPTION: New York's regulations require that a facility reduce overall plant emissions to within the compliance level of 100 tons/yr. As an option, Lustreprint chose to reduce the use of solvent-based inks and adhesives. The first step eliminated solvent-based adhesives used in laminating. This was followed by a phase-in of water based inks to replace the existing solvent-based inks in the printing operation. The company goals were to reduce all volatile organic air emissions to an extent that would eliminate the need for costly air abatement and permitting and to eliminate all liquid-phase solid waste, characterized as hazardous waste at the facility. To achieve these goals, ink use was monitored over four one-week-long study periods: 3-weeks when both water-based and solvent-based inks were used. Historical data for emissions and waste generation were extrapolated for comparison with the weekly experimental data.

TECHNOLOGY EVALUATION: Substituting water-based inks required press modifications. The installment of an in-line corona discharge treater allowed the use of higher surface tension water-based inks. VOC emissions were reduced by approximately 72.5% when compared with those for water-based solvent. For every 1% increase in water-based ink use, VOC emissions were reduced 14 pounds. Historically, 424 lb/wk of solid waste was generated each month. The net result in week 1 was an 87% decrease from normal in solid waste generation (from 424 lbs to 55.5 lbs); a 95% decrease in week 2 (to 20.0 lbs); and 100% elimination of solid waste generation in weeks 3 and 4.

ECONOMIC EVALUATION: The payback period for the corona treater and equipment modifications is 2.56 years. The payback period could be further reduced by eliminating the solid waste disposal. With the complete change over to water inks and the planned purchase of an ink splitter (absorbs various ink pigments on a cellulose-based porous material), additional savings for solid waste disposal is possible. The payback period would then be reduced to 0.54 years. The economic evaluation indicates that the decision to substitute the water inks for solvent inks was financially beneficial.

CONCLUSIONS: This project resulted in a double benefit for Lustreprint: they have reduced their VOC emissions and reduced process costs. This successful implementation of water-based inks in flexographic wide web printing should be considered as a VOC source reduction method for similar printing operations. Additional benefits from reduced VOC emissions and liquid hazardous waste have been an improved working environment: reduced indoor air pollutants, reduced handling of hazardous solvents by employees, and a conscious effort by employees to reduce waste generation.

PRINCIPAL INVESTIGATOR: P. B. Kranz
Erie County Department of
Environment and Planning
Buffalo, New York 14202

EPA PROJECT MANAGER: Paul M. Randall
US EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7673

KEY WORDS: ink substitutions; wide web flexographic printing process; VOC emissions; adhesives; solvent-based; water-based inks; press modifications

TITLE: Recycling Nickel Electroplating Rinse Waters by Low Temperature Evaporation and Reverse Osmosis

INTRODUCTION: This project was performed to evaluate, compare, and document the effectiveness of low temperature evaporation and reverse osmosis technologies for recovery and reuse of water and plating bath chemicals associated with electroplating rinse waters. These technologies were examined at a small scale at the HWRIC pilot laboratory facility by using actual rinse water samples collected from a Graham Plating nickel electroplating line. Nickel analyses were done to determine how efficiently the systems removed nickel from the rinse water and concentrated it for potential recycling. Analyses for total organic carbon (TOC) were done to indicate the fate of organic constituents in the rinse water. Electric conductivity was also measured following sample collection.

BACKGROUND INFORMATION: This project was a joint effort of Graham Plating, Chicago, IL, an electroplating firm; the Hazardous Waste Research and Information Center (HWRIC), a division of the Illinois Department of Energy and Natural Resources, Champaign, IL; and the Pollution Prevention Research Branch of the U.S. Environmental Protection Agency's Risk Reduction Engineering Laboratory, Cincinnati, OH. Graham Plating will relocate to a new facility that is designed and constructed such that special features have been installed to facilitate accumulation, segregation, and storage of rinse waters by principal metal component. This water can subsequently be treated through a reverse osmosis system, a low temperature evaporation unit, or both.

TECHNOLOGY DESCRIPTION: Low temperature evaporators heat water under a vacuum to produce steam at relatively low temperatures. The steam rises into a condenser where distilled water results. The plating bath chemicals do not rise with the steam and become a concentrated slurry or solution of chemicals. Reverse osmosis is a pressure-driven membrane separation process in which a feed stream under pressure (200-800 psi) is separated into a purified "permeate" stream and a "concentrate" stream by selective permeation of solution through a semi-permeable membrane. The pressure required to force the permeate through the membrane is dictated by the osmotic pressure of the feed stream.

TECHNOLOGY EVALUATION: The low temperature evaporation system exhibited consistent productivity throughout the tests. This performance feature was unfailing regardless of the chemical concentrations of the feed solution provided to the system. The nickel concentration in the distillate produced by the low temperature evaporation system was very low. Additionally, TOC concentrations in the distillate were very low.

The reverse osmosis system exhibited superior productivity at the beginning of the tests, and productivity dropped off dramatically after about 60% of the feed solution had been processed. Beyond these levels, the productivity of the reverse osmosis equipment decreased dramatically as solids began to precipitate and foul the membrane. The reverse osmosis system, however, would probably produce excess volumes of concentrated rinse water composed of 1.2% to 1.8% nickel. This material would have to be further processed with the use of an alternative technology such as low temperature evaporation. TOC concentrations averaged 19.46 to 21.98 mg/L in the permeate solution which suggests that some of the organic compounds were able to permeate the membrane. Advantages of the reverse osmosis system include its relatively high production rates with respect to low concentration feed solutions. The disadvantage associated with the reverse osmosis system is the lower quality permeate produced by the system. The concentrate produced by the system does not meet the requirements for the plating bath.

The electrical conductivity data obtained in this project were well correlated with nickel concentration, TOC concentration, and membrane flux characteristics. Accurate assumptions regarding concentrate, permeate, and distillate could be based on electrical conductivity measurements taken throughout the day.

ECONOMIC EVALUATION: Disadvantages of the low temperature evaporation system include its relatively high ($140,000) capital cost and high energy requirements. These costs, however, do not consider the reduced future liabilities brought about by drastically decreasing the hazardous waste discharges from the facility. The reverse osmosis unit, on the other hand, would require lower capital investment (about $50,000) than a comparably sized low temperature evaporation system.

CONCLUSIONS: Both the low temperature evaporation and reverse osmosis systems appear to offer advantages under specific operating conditions. The reverse osmosis system is best adapted to conditions where the feed solution has a relatively low nickel concentration. The low temperature evaporation system appears to be best adapted to processing solutions with relatively high nickel concentrations. Using the equipment within its optimum operating ranges would augment the ability of the systems to process the rinse water with maximum efficiency while supplying the electroplating operation with high-quality concentrate, distillate, and permeate solutions for reuse. Since the equipment would always be functioning within optimum concentration ranges, a combined system of smaller reverse osmosis and low temperature evaporation units would offer greater advantages than if the units were used alone. If this type of combined system were installed at the Graham Plating facility, it would require a capital investment of $115,000 which would be paid back in 2.8 yr. through a 27.6% implied rate of return.

PRINCIPAL INVESTIGATOR: Timothy C. Lindsey
Hazardous Waste Research
and Information Center
Champaign, Illinois 61820

EPA PROJECT MANAGER: Paul M. Randall
US EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7673

KEY WORDS: low temperature evaporation; reverse osmosis; recovery and reuse of water and plating bath chemicals; nickel concentration; rinse waters

TITLE: A Fluid Sorbent Recycling Device for Industrial Fluid Users

INTRODUCTION: In the process of mixing, handling, and packaging of fluids, spills occasionally occur. Spilled or splattered fluid is removed by hand with sorbent pads made of melt-blown polypropylene. Once the pads are saturated with fluid, they are drummed for disposal. This study is a cooperative effort between U.S. Environmental Protection Agency's (EPA's) Waste Reduction Innovative Technology Evaluation (WRITE) Program and Cook's Industrial Lubricants, Inc. in Linden, NJ. The goal of this study was to evaluate a technology that extracts fluids such as mineral oils, cutting fluids, and solvents from sorbent pads by roller compression. The *Extractor*, manufactured by Environmental Management Products recovers the fluid by compressing the pads between two gear-driven counter-rotating rollers. The *Extractor* has the potential to reduce the number of sorbent pads used and the volume of sorbent pads and fluids sent to disposal.

TECHNOLOGY DESCRIPTION: Two types of wastes were considered in this study-spent sorbent pads and waste fluid. The roller compression method extracts the sorbed fluid and permits reuse of the pads. The extracted contaminated fluid is then further processed for reuse. Because fluid removal is dependent on the fluid viscosity, tests were conducted with three different fluids covering a range of viscosities. The ability of sorbent pads to leave a clean floor after use was measured by the fluid pickup test. The percentage of pickup by a new pad was compared with that of recycled pads.

TECHNOLOGY EVALUATION: The sorbent pad recycling evaluation demonstrated that roller compression technology can be effectively used to extract low- and medium-viscosity fluids from melt-blown polypropylene sorbent pads. The *Extractor* is particularly useful for low-viscosity fluid applications; the sorbent pads can be used at least eight times. For medium-viscosity fluids, no more than two to three reuse cycles are possible. For high-viscosity fluids, the sorbent pads can only be used once. The number of pads disposed of is reduced significantly as is noted by the number of drums for disposal of pads reduced from 24 drums to 6.5 or 1.6 drums. The 14 to 16 drums of waste fluids extracted from the sorbent pads would be processed for reuse or hauled away for disposal at a waste-to-energy facility. The fluid pickup tests showed that regardless of fluid types, the sorbent pads effectively removed fluids from the floor. Moreover, the sorbent pads effectively removed low- and medium-viscosity fluids even after they were reused four or eight times.

ECONOMIC EVALUATION: For low-viscosity fluid, substantial savings occurred as a result of pad recycling. Savings of up to 51.4% and 75.3% were possible with as few as two and as many as eight reuse cycles. The cost per use was also greatly reduced, from $4.80 for single use to $1.19 for eight uses. For medium-viscosity fluid, the annual pad recycling savings were 50.5% and the per use cost was $2.38 for two uses. Additional savings are unlikely since the sorbent pads became severely separated and deformed as a result of the extraction process. The capital cost for the *Extractor* is relatively insignificant ($699) and the annual savings is substantial, therefore the payback period of the investment is 2.8 to 5 weeks.

CONCLUSIONS: The roller compression technology shows potential for reducing sorbent pads used and volume of sorbent pads and fluids sent to disposal. The sorbent pads exhibited enduring performance to retain and remove low-viscosity fluids after being compressed repeatedly through the *Extractor*. The sorbent pads were largely separated and deformed after two (and more than three) extraction cycles when used for medium-viscosity fluids however. The sorbent pads soaked with high viscosity fluids did not pass through the *Extractor* and therefore, are disposed of after one use. The use of the *Extractor* by shops and plants would result in annual savings of 51%-75%. Further savings can be achieved by recycling the extracted fluids.

PRINCIPAL INVESTIGATOR: A. S. C. Chen
Batelle Memorial Institute
Columbus, Ohio 43201-2693

EPA PROJECT MANAGER: Johnny Springer
US EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7542

KEY WORDS: spills; mixing, handling and packaging of fluids; roller compression; sorbent pads; fluid viscosity; fluid pickup test; extraction cycles

TITLE: NMP-Based Coatings Remover at Tooele Army Depot

INTRODUCTION: The goal of this study is to evaluate a replacement solvent paint remover for methylene chloride and other hazardous compounds that can be used to remove organic coatings, such as enamels, lacquers, and varnishes from metal surfaces. Methylene chloride is a primary component of many cold paint removers and is one of the substances targeted by the 33/50 Program for use reduction. U.S. EPA considers methylene chloride to be a hazardous air pollutant because of its low exposure limit and high volatility. The paint remover to be evaluated is based on n-methyl-2-pyrrolidone (MNP) and also contains monoethanolamine (MEA). NMP is a highly versatile solvent that has been used for more than 15 years in the chemical and petrochemical industries. MEA is used as a co-solvent that helps accelerate removal of paint and other organic contaminants.

BACKGROUND INFORMATION: Tooele Army Depot (TEAD) provided the site for this technology demonstration. TEAD is a government-owned, government-operated (GOGO) installation, located in Tooele, UT, since 1943. It is one of the 12 depots and 6 depot activities in the Depot System Command (DESCOM). TEAD's primary function is to overhaul the Army's tactical wheeled vehicles and associated secondary items, including trucks, trailers, engines and transmissions. TEAD also overhauls and repairs many other types of troop support equipment, including generators, topographical and surveying equipment, and reproduction equipment.

TECHNOLOGY DESCRIPTION: The focus of this study is on the parts Chemical Cleaning System(PCCS), which is designed for depainting, cleaning and parts and powertrain subassemblies. Only the nonferrous cleaning line was the subject of this study. Application of conversion coatings is a surface preparation method to provide corrosion protection and increase adhesion of the paint coating. PCCS is designed such that an automated overhead monorail transport baskets of parts through tanks of paint remover and various rinses, before applications of conversion coatings. The system employs automatic controls to regulate tank solution levels, temperatures, agitation tank ventilation, tank heating and solution filtration.

This evaluated three objectives. First, the study evaluated the ability of replacement paint remover to remove paints and compared these results with those using the old technology (methylene chloride). The pollution prevention potential of the new paint remover and rinse water purification system was evaluated. Finally, the economic potential of the paint removal process was compared with the cost of using the methylene chloride paint removal system.

CONCLUSION: To evaluate product quality, test coupons were made and processed through the paint remover system along with actual parts. An equal number of coupons were coated with heat resistance or chemical agent resistant coatings. The degree of paint removal from the coupons was qualitatively evaluated. The baskets of actual parts were evaluated on a pass/fail basis. To evaluate the pollution prevention potential of the new paint remover solvent system, three process streams were evaluated. Qualitative analysis of the test coupons and parts batches indicates that the NMP-based solvent removed the paint as well as did the methylene chloride paint removal system.

PRINCIPAL INVESTIGATOR: Bruce Sass
Battelle
505 King Ave.
Columbus, Ohio 43201

EPA PROJECT OFFICER: Johnny Springer, Jr.
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7542

KEY WORDS: replacement solvent paint remover; methylene chloride; n-methyl-2-pyrrolidone; rinse water purification system

TITLE: Bicarbonate of Soda Blasting Technology for Aircraft Wheels Depainting

INTRODUCTION: The goal of this study was to evaluate a bicarbonate of soda depainting technology that uses sodium bicarbonate based blasting media to replace chemical solvents, such as trichloroethylene (TCE), for stripping paints from aircraft wheels. Specifically, this study evaluated (1) effectiveness of this technology, (2) the waste reduction and pollution prevention potentials, and (3) the economics.

TECHNOLOGY DESCRIPTION: Bicarbonate of soda blasting is a relatively new process that is commercially available. Compressed air delivers sodium bicarbonate media from a pressure pot to a nozzle where the media is mixed with a stream of water. The media/water mixture impacts the coated surface and removes old coatings from the substrate. The water used dissipates the heat generated by the abrasive process, aids the paint removal by hydraulic action, and reduces the amount of dust in the air. As another convenience, the workers do not need to prewash or mask the surface. The dust, unlike that of plastic media, is not an explosive hazard, nor is sodium bicarbonate toxic in this form. The airborne particulates generated from the stripping operation, however, can contain toxic elements from the paint being removed.

The effectiveness of bicarbonate of soda blasting depends on optimizing a number of operating parameters including nozzle pressure, standoff distance, angle of impingement, media flow rate, water pressure, and traverse speed.

TECHNOLOGY EVALUATION: The waste reduction was measured in terms of volume reduction and pollutant reduction. Volume reduction addressed the gross wastewater such as liquid and solid wastes in the vat and wastewater in the rotoclone separator. Pollutant reduction involved individual pollutants, such as oil and grease, total suspended solids(TSS), and heavy metals in the gross wastestream. Pollutants reduction addressed the specific hazards of individual pollutants.

About 30 gal of wastewater was generated and collected in a vat during each of the blasting sessions. Air emissions were measured in the breathing zone of the operator and analyzed for Cd, Cr, Cu, Pb, and Zn. The cloud of mist created around the blasting activity was maintained within the work area and removed by a ventilation system consisting of an exhaust hood and rotoclone dust separator.

ECONOMIC EVALUATION: Cost comparison were made for bicarbonate blasting vs. chemical stripping. Blasting times to strip each wheel were measured during the test. NASA/JSC historical data were used to determine chemical stripping times. The capital investment, operating costs, and payback period were calculated according to the work sheets provided in the U.S. EPA Waste Minimization Opportunity Assessment Manual. The results of the economic analysis indicated that a return on investment(ROI) greater than 15% (which is the cost of capital) could be obtained in 4 years, or payback period for NASA/JSC would be 4 years.

CONCLUSION: The bicarbonate of soda blasting evaluation concludes that the blasting technology can effectively strip paint from aircraft wheels. The blasting technology substantially reduced the number of man-hours required for paint stripping in comparison to chemical stripping. The time saved was more than 95%. The quantity to be shipped away as hazardous waste was about 7.5 agl/ T-38 aircraft wheel. The solid waste in the vat contained paint chips and debris, most of which was insoluble under the toxicity characteristic leaching procedure (TCLP) conditions. The wastewater in the rotoclone separator could be sewered without treatment. Although convenient for this application and for the existing local limits, the source reduction of this waste as well as reuse/recycling should be investigated in greater depth.

The blasting technology has good potential for reducing waste and the consequent waste disposal costs. For the application studied, this is primarily the result of changing the waste from a

RCRA hazardous category to a nonhazardous category. Paint stripping shops may find this technology beneficial, especially as more stringent federal and local regulations are implemented for the disposal of the toxic solvent-contaminated wastes.

PRINCIPAL INVESTIGATOR: A.S.C. CHEN
Battelle
Columbus, Ohio 43201-2693

EPA Project Officer: Ivars Licis
US EPA
Cincinnati, Ohio 45268
(513) 569-7718

KEY WORDS: bicarbonate of soda, depainting technology; replace chemical solvents; compressed air; media/water mixture; gross wastewater; oil;grease; heavy metals; total suspended solids

TITLE: Electronic Component Cooling Alternatives: Compressed Air and Liquid Nitrogen

INTRODUCTION: This study evaluated the use of cold compressed air tools and liquid nitrogen as methods for cooling electronic circuits while searching for causes of thermally intermittent circuit failures. Aerosol cans of refrigerant(i.e., CFC R-12 and HCFC R-22), which commonly have been used in electronics manufacturing and repair business for this purpose, served as the benchmark for the evaluation. Six critical parameters were measure for each cooling method: accuracy, electrostatic discharge risk, cooling capability, technician safety, pollution prevention potential, and economics.

TECHNOLOGY DESCRIPTION: Aerosol cans of refrigerant, such as R-12 and R-22, are commonly used in the electronics manufacturing and repair industries for trouble-shooting circuit boards that have known or suspected thermally intermittent failure modes. Thermally intermittent failures occur when temperature changes and material expansion or contraction aggravate the mechanical failure to create an electrical discontinuity condition. For example, if an electronic device works when first turned on but fails as it warms up in operation, a technician may spray refrigerant towards board areas or on specific components to reduce temperatures until the device begins to work again. The component that, when cooled, causes the failure mode to appear or disappear is replaced. If the circuit failure mode still exists, the troubleshooting process is repeated.

The first alternative technology evaluated was a compressed-air tool that provides a continuous stream of cold air that can be directed towards components. Compressed air enters a tangentially drilled stationary generator which forces the air to spin down the long tube's inner walls toward the hot-air control valve. A percentage of the air, now at a atmospheric pressure, exits through the needle valve at the hot-air exhaust. The remaining air is forced back through the center of the sonic-velocity airstream where it moves at a slower speed, causing a simple heat exchange to take place. The inner, slower-moving air gives up heat to the outer, faster-moving air column. When the slower inner air column exits through the center of the stationary generator and out the cold exhaust, it has reached an extremely low temperature. To obtain temperatures in the range of -35 C to -40 C, the tool requires clean, dry, room-temperature air flowing at 15 scfm at 100 psi pressure.

The second alternative technology evaluated uses liquid nitrogen. A 1/2-L Dewar flask can be used with a release valve that allows a stream of nitrogen gas and liquid droplets to be directed through a small-diameter stainless-steel nozzle. As the valve and the nozzle are cooled by the nitrogen flow, the portion of the stream that is droplets increases and the output stream drops in temperature. A variety of valves, nozzles, and heat exchangers are available to tailor the delivery and cooling characteristics of the stream of nitrogen. The Dewar flask can be refilled from a bulk container of liquid nitrogen.

TECHNOLOGY EVALUATION: Three factors determine how well a given cooling method will work to identify failing circuit board components: accuracy, electrostatic discharge risk, and the cooling rate and absolute temperature drop.

* Accuracy - For this project, accuracy was defined as the capability of a technician using a cooling method to identify a specific component with a thermally intermittent failure mode causing a circuit board to have a thermally intermittent circuit failure mode. An accurate cooling method provides a high component identification confidence (CIC) level, which avoids the cost of erroneously replacing nondefective components, potential damage created during component replacement, and multiple iterations of testing and repair. The number and variety of test articles identified during the test period were not as great as hoped for. Also, the results of the test article evaluations do not support comparisons of the accuracy of the cooling methods. However, the results do indicate that the compressed-air method was abie to reproduce circuit failures in 12 of 13 test articles.

* Electrostatic Discharge Risk - The amount of electrostatic charge buildup generated by the cooling material as it is dispensed is a concern because components can be damaged by electrostatic discharge. Two experiments were designed to compare the discharges generated. Averages of each of

the pairs of measurements indicate that both the compressed air and the liquid nitrogen alternatives generated lower electrostatic charge buildup than did R-12.

* Cooling Rate and Absolute Temperature Drop - They were measured for each method. The absolute temperature drop data presented were used for direct comparison of cooling materials; but cooling rate and temperature difference data were not used for direct comparisons.

CONCLUSION: Neither alternative is expected to increase safety risks to technician when compared with those of aerosol refrigerants. Handling of liquid nitrogen presents a safety risk in the form of exposure to low temperatures. Compressed air generates a small amount of pollution in the forms of waste compressor oil and filter elements, but the incremental increase in these wastestreams that would follow adoption of the compressed-air method is not expected to be significant.

PRINCIPAL INVESTIGATOR: Stephen Schmitt
Battelle
Columbus, Ohio 43201-2693

PROJECT OFFICER: Johnny Springer, Jr.
US EPA
Cincinnati, Ohio 45268
(513) 569-7542

KEY WORDS: cold compressed air tools; liquid nitrogen; accurate cooling method: electrostatic discharge risk; cooling capability; technician safety; aerosol cans; trouble-shooting circuit boards

SECTION 2

WASTE REDUCTION EVALUATIONS AT FEDERAL SITES PROGRAM

(WREAFS)

Overview

The Waste Reduction Evaluations at Federal Sites (WREAFS) Program consists of a series of demonstration and evaluation projects for waste reduction conducted cooperatively by the U.S. Environmental Protection Agency (EPA) and various parts of the Department of Defense, Department of Energy, and other federal agencies. The WREAFS Program focuses on waste minimization research opportunities and technical assessments at federal sites. The objectives of the WREAFS Program include: (1) conducting waste minimization workshops; (2) performing waste minimization opportunity assessments; (3) demonstrating waste minimization techniques or technologies at federal facilities; and (4) enhancing waste minimization benefits within the Federal community.

The WREAFS Program facilitates the adoption of pollution prevention/waste minimization practices through technology transfer. New techniques and technologies for reducing waste generation are identified through waste minimization opportunity assessments and may be further evaluated through joint research, development, and demonstration projects. The waste minimization opportunity assessments follow the procedures outlined in the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988). The major phases of a WREAFS assessment are:

(1) **Planning and Organization:** organization goal setting

(2) **Assessment:** careful review of a facility's operations and wastestreams and the identification and screening of potential options to minimize waste

(3) **Feasibility Analysis:** evaluation of the technical and economic feasibility of the options selected and subsequent ranking of options and

(4) **Implementation:** procurement, installation, implementation, and evaluation (at the discretion of the facility surveyed).

TITLE: Pollution Prevention Opportunity Assessment for Two Laboratories at Sandia National Laboratories

INTRODUCTION: Sandia National Laboratories (SNL) is a federally owned DOE facility located in Albuquerque, NM. Sandia's primary mission is national security, with principle emphasis on nuclear weapons development and engineering. As by-products of production, research and development, and environmental restoration activities, Sandia generates a variety of waste materials that are carefully controlled during operations and regulated by the federal government and state and local agencies. Under the purview of the WREAFS Program, SNL and EPA conducted pollution prevention opportunity assessments (PPOAs) for two laboratories within the SNL complex. The PPOAs were conducted at the Geochemistry Laboratory (GL) aand the Manufacturing and Fabrication Repair Laboratory (MFRL) at DOE's SNL facility as part of EPA's WREAFS Program.

BACKGROUND INFORMATION: The United States government, through legislative and executive actions has mandated waste minimization as a national environmental policy. Federal statutes, such as the Resource Conservation and Recovery Act Amendments of 1984 and the Pollution Prevention Act of 1990 affect all waste generators, including federal facilities. To support pollution prevention activities at federal facilities, EPA has established the WREAFS Program. WREAFS provides funding and technical assistance for pollution prevention efforts at a wide variety of federal facilities.

TECHNOLOGY DESCRIPTION: The GL performs analysis of earth materials and simulates earth conditions. The types of research performed by the GL fall into three major categories differing in research control. The largest waste stream by volume, generated by the GL is Polaroid film backs from Scanning Electron Microscopy (SEM) photography. The use of prior waste generation data is not an optimal indicator of future waste generation to measure the success of pollution prevention projects.

The MFRL typically repairs printed circuit board assemblies (mother boards) for use in satellite systems. Approximately 683 lb/yr of waste are generated from the MFRL. Bulk solvent accounts for approximately 88% of the waste generated. Wastes and input materials are primarily related to board repair, but a portion results from repair of box assemblies and cables.

TECHNOLOGY EVALUATION: The number of laboratories at SNL and the nature of laboratory work result in a large number of small quantity waste streams being generated. This presents certain obstacles to pollution prevention initiatives. The feasibility of pollution prevention opportunities discussed in the report is largely dependent on the attitude and confidence of SNL's researchers. For the GL Laboratory, significant reductions in waste generation can be achieved through education and training. Building pollution prevention into research proposals is one of the most feasible initiatives. Site-wide pollution prevention opportunities offer the greatest potential for waste reduction. The site-wide options identified are technically feasible. The repair room, vapor degreasing room, and storage room for the MFRL were evaluated. Several options were identified for each waste stream. Rinse water was tested to determine its toxicity and, therefore to determine its use for other non-potable purposes. Nonflammable, contaminated laboratory trash is placed in Ziplock bags. The Ziplock bags contain mostly air. By keeping a lined 20-gal polyethylene container in the vapor degreasing room, the use of Ziplock bags could be eliminated. Uncontaminated end-of-swab sticks could be reused by the technician after breaking off the contaminated ends. Eliminating bench cleaning would reduce the amount of solvent- and flux-contaminated lab trash generated. In addition the number of wipes and swabs expended would be less.

ECONOMIC EVALUATION: For the GL laboratory, increased costs are incurred initially, but the increase is offset by savings in disposal costs. The rinse water testing results in annual savings of $139.50. The raw material cost savings from not having to purchase Ziplock is estimated at $100. A net annual savings of $128.40 would be achieved and the payback period is 0.24 years. The net annual savings for reusing swabsticks would be $22.28. The raw material cost savings are $26.15 for eliminating bench cleaning. The expected net annual savings is $89.26 with a payback period of zero years. Therefore, the small savings from many laboratories can result in significant savings over the long run.

CONCLUSIONS: For the GL laboratory, implementation of concepts identified during this WREAFS project would further enhance SNL's pollution prevention program. EPA recommendations to DOE and SNL include but are not limited to 1) building pollution prevention into research projects from the start 2) escrowed closeout money can be set aside at the beginning of a project so that potential reuse, proper characterization, and appropriate management of chemicals can be maximized, and 3) funding of site wide projects to make the system more effective. These alternatives provide promising turnouts but the recommendation with the largest potential for pollution prevention gains is to continue SNL's education and training. Of the four options evaluated in detail for the MFRL, eliminating Ziplock bags appears to be the most promising. The waste reduction achieved from any of the options evaluated is small, but are easily implemented and savings could be gained quickly.

PRINCIPAL INVESTIGATOR: Science Applications International Corporation
Cincinnati, Ohio 45203

EPA PROJECT OFFICER: James S. Bridges
US EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7683

KEY WORDS: geochemistry laboratory; manufacturing and fabrication; repair laboratory; earth materials; satellite systems; bulk solvent; small quantity waste streams; rinse water;

TITLE: Evaluation of Propylene Carbonate in Air Logistics Center Depainting Operations

INTRODUCTION: The Strategic Environmental Research and Development Program (SERDP) was established two years ago in order to sponsor cooperative research, development and demonstration activities for the environmental risks reduction. Funded with the Department of Defense(DoD) resources, SERDP is an interagency initiative between DoD, DOE and epa. SERDP seeks to develop environmental solutions for federal activities that are applicable across the public and private sectors.

BACKGROUND INFORMATION: In September 1992, EPA completed a study of the use of 1,1,1-trichloroethane(methyl chloroform), xylene, and methyl ethyl ketone(MEK) (2-butanone) in aerospace operations, due to their widespread use through the industry. Considerable research on solvent substitution for methyl chloroform is ongoing due to this chemical's schedule phaseout in year end 1995 as a result of the Montreal Protocol. MEK and xylene are considered volatile organic compounds (VOCs) and are listed as Hazardous Air Pollutants under the Clean Air Act. Various contacts within the aerospace and defense community indicate that MEK and its regulatory and disposal issues are significant problems within the industry and worthy of immediate research activities.

MEK is a solvent used for depainting aircraft radomes at the Oklahoma City Air Logistics Center (OCALC) at TAFB. TAFB removes paint from radomes on KC-135, EC-135, B-52, B-1, and E-3A aircraft. In a large ventilated booth, MEK is applied to "depaint" the radome. The MEK attacks the primer through scribed breaks in the topcoat. The paint starts to bubble after 30 minutes of continuous showering. As the primer dissolves, the topcoat is flushed away from the radome by MEK shower. Topcoat residue is filtered from the MEK. The solvent then flows to a sump for recycle back to the spray header. The operation typically takes 1.5 to 3 hours. According to TAFB, a large percentage of MEK is lost to the atmosphere through the booth exhaust system because of the chemical's high volatility. After the MEK application, any remaining paint residues are removed by hand sanding. Topcoat chips are captured in a sump and disposed as hazardous waste. In 1991, 719 pounds of topcoat chips were disposed, and an estimated 8,250 gallons of MEK evaporated to the atmosphere.

From a review of alternative paint stripping chemicals on the market, n-methyl-2-pyrrolidone (NMP) has demonstrated potential for removing paint from structures with composite substrates. The physical properties of NMP that make it favorable for the use in paint stripping are its low flammability, low evaporation rate, solvency power, ease in blending with other solvents, and its potential biodegrability.

TECHNOLOGY DESCRIPTION: From its research and in cooperation with Texaco, RREL identified solvent formulations based on PC and NMP as possible alternatives for MEK. Texaco Chemical Company demonstrated unique abilities in the area of solvent applications research and volunteered to assist in the research. For pre-screening, Texaco used a computer program to predict properties of various solvent blends and to select potential blends, based on criteria entered into the program. The selection criteria for the PC solvent blends included:

* Nonhazardous mixture
* Low volatility
* Safe to handle
* Flash point > 140 F
* Biodegradable

After lab scale testing , three solvents formulations demonstrated favorable performance characteristics and were selected for a screening performance with MEK to determine which solvent blend would undergo further testing. One formulation designated "PC Blend 2" was chosen because of its effectiveness and speed in removing the coating. PC Blend 2's composition is:

* 25% PC
* 50% NMP
* 25% DBE

CONCLUSIONS: Currently EPA is reviewing the data from this study and is preparing a report and technical article for publication. Although the data have not yet cleared the Agency's quality assurance review, the potential of the PC blends encourages further investigation. Interim results suggest that a formulation of PC, NMP and DBE can be produced to remove paint in comparable time to the MEK. For solvent properties, the PC blend promises to compare favorably with MEK with minimimal effects on the environment and health and safety. The anticipated benefits include the elimination of 33/50 toxic chemical, MEK, from the radome depainting operation, along with the VOC air emissions.

PRINCIPAL INVESTIGATOR: Ann Marie Hooper
Foster Wheeler USA Process Plants Division
Clinton, NJ 08809

EPA PROJECT MANAGER: Johnny Springer, Jr. and Kenneth R. Stone
US EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7542

KEY WORDS: solvent substitution; methyl chloroform phaseout; 1,1,1-trichloroethane; methyl ethyl ketone; n-methyl-2-pyrrolidone; alternatives to remove paint

SECTION 3

UNIVERSITY-BASED ASSESSMENTS PROGRAM

Philadelphia, Pennsylvania

Overview

The University-Based Assessments Program is a pilot project between EPA and the University City Science Center (UCSC) to assist small and medium-size manufacturers who want to minimize their formation of hazardous waste but who lack the in-house expertise to do so. Under agreement with the Risk Reduction Engineering Laboratory of the U.S. Environmental Protection Agency, UCSC's Industrial Technology and Energy Management (ITEM) division has established three waste minimization assessment centers (WMACs) at Colorado State University in Fort Collins, the University of Louisville (Kentucky), and the University of Tennessee in Knoxville. Each WMAC is staffed by engineering faculty and students who have considerable direct experience with process operations in manufacturing plants and who also have knowledge and skills needed to minimize hazardous waste generation.

The WMACs conduct waste minimization assessments for small and medium-size manufacturers at no out-of-pocket cost to the client. To qualify for the assessment, each client must meet the following criteria:

* Standard Industrial Classification Code 20-39
* Gross annual sales of not more than $75 million
* No more than 500 employees
* Lack of in-house expertise in waste minimization

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers, reduced waste treatment and disposal costs for participating plants, valuable education experience for graduate and undergraduate students who participate in the program, and a cleaner environment without more regulations and higher costs for manufacturers.

The waste minimization assessments require several site visits to each client served. In general, the WMACs follow the procedures outlined in the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988). The WMAC staff locate the sources of hazardous waste in each plant and identify the current disposal or treatment methods and their associated costs. They then identify and analyze a variety of ways to reduce or eliminate the waste. Specific measures to achieve that goal are recommended and the essential supporting technological and economic information is developed. Finally, a confidential report which details the WMACs findings and recommendations including cost savings, implementation costs, and payback times is prepared for each client. UCSC conducts follow-up interviews with the client to determine actual costs and benefits of the recommendations. Research Briefs are prepared and distributed by EPA to transfer the technical information to others. These Research Briefs are available from EPA's Center for Environmental Research Information. The full reports on this research are available from the University City Science Center, Philadelphia, PA 19104. At the completion of this pilot effort with UCSC, one hundred facilities will have waste minimization opportunity assessments with documented results of findings and recommendations.

TITLE: Manufacturer of Parts for Truck Engines

PLANT BACKGROUND: The plant manufactures turbochargers, fan drives, and vibration dampers for truck engines. It operates approximately 6,000 hr/yr to produce more than 600,000 units annually.

MANUFACTURING PROCESS: The major raw materials used by the plant are iron, aluminum, magnesium, and steel castings. Other raw materials include bearings, finger sleeves, bands, studs, and rubber strips.

For the production of turbocharges, steel castings undergo a vapor degreasing operation and friction welding. In parallel operations, the steel castings, aluminum castings, and iron castings are turned, drilled, tapped, and sent through an alkaline cleaner. The finished parts are assembled into complete turbocharger units, packaged, and shipped.

In the fan drive production line, aluminum, magnesium, iron, and steel castings are turned, drilled, and tapped, resulting in rotors, shafts, and bearing housings. Rotors are sandblasted, vapor degreased, spray-coated with a wear-resistant formulation, and heated in a curing oven. The shafts and bearing housings, after an alkaline cleaning, are assembled with the finished rotors. The finished product is packaged and shipped.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following techniques to manage and minimize its waste:

* Onsite solvent recovery units are used to distill spent degreasing solvent for reuse.
* Several waste streams, including an anti-rust treatment and cleaning chemicals have been eliminated from the production process.
* A heat pump evaporator has been purchased for drying of wastewater sludge.
* Waste cardboard is baled and sold to a recycler.
* Waste metals are compacted into blocks and sold as scrap.

WASTE MINIMIZATION OPPORTUNITIES:

* Reduce the frequency of leaks and spills of hydraulic oil.
* Dispose of spent coolant through a method other than the onsite wastewater treatment plant.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: turbochargers; fan drives; vibration dampers; vapor degreasing operation; friction welding; rotors; sandblasted; spray-coated; on-site solvent recovery; heat pump evaporator

TITLE: Manufacturer of New and Reworked Rotogravure Printing Cylinders

PLANT BACKGROUND: The plant produces chrome-plated engraved copper-plated steel and aluminum cylinders for rotogravure printing from new stock and customer returns. It operates 6,240 hr./yr to produce over 7,000 cylinders annually.

MANUFACTURING PROCESS: Rotogravure printing cylinders are produced from new stock (primarily steel or aluminum) and from used cylinders requiring reworking.

New cylinders are cleaned and degreased before processing. Then the aluminum cylinders are passivated in a wash tank containing an acid mixture, and zincated in a zinc oxide solution. Next, all aluminum and steel cylinders are nickel-plated and then copper-plated. The plated cylinders then undergo lathing, polishing, and grinding.

Customer-provided art work is used to create plating images which are then mechanically engraved on the surfaces of the cylinders. The engraved cylinders are cleaned, polished, and chrome-plated.

Cylinders are then tested in the proofing department. Those cylinders that pass inspection are packaged and shipped. The cylinders that fail inspection are stripped of chrome (using acid) and are either replated with chrome or lathed and returned to the copper-plating baths for reprocessing.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has taken the following steps to manage and minimize its wastes:

* Metal shavings from turning, polishing, and electronic engraving are recovered and sold for reclamation.
* Cylinders are rinsed with deionized water directly above the tanks after nickel and copper plating in order to eliminate drag-out of plating solution.
* Nickel plating has been substituted for cyanidin prior to copper-plating thereby eliminating the generation of cyanide wastes.
* Film with a very low silver content is used in image processing in order to reduce the amount of waste silver generated.
* Silver is recovered onsite by electrolytic deposition.
* Recovered silver and waste film are sold to a recycler.
* Electronic engraving is used for etching cylinders in order to eliminate the wastes that would be generated using chemical etching.
* Cylinders are rinsed over the planting tanks and fume scrubber water is reused as plating bath make-up in order to eliminate the need for chromium removal from wastewater.
* Chromic acid fume losses are reduced through the use of tank covers and floating ball insulation.

WASTE MANAGEMENT OPPORTUNITIES:

* Reduce or eliminate spill over from the nickel and copper-plating by installing plastic guards around the tank edges.
* Evaluate the necessity for and standardize the use of solvents for the cleaning of cylinders.
* Recover chromium or hydrochloric acid from the spent acid stripper solution.
* Replace disposable filters used for filtering nickel and copper-plating solutions with reusable stainless steel filters.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: rotogravure printing; chrome-plating; engraved copper-plated steel; aluminum cylinders; polishing; electronic engraving; nickel plating; electrolytic deposition; chromic acid fume

TITLE: Manufacturer of Electrical Rotating Devices

PLANT BACKGROUND: Several varieties of electrical rotating devices are manufactured by this plant. It operates over 4,000 hr/yr to produce more than 250,000 units annually.

MANUFACTURING PROCESS: Carbon and stainless steel, aluminum, brass and copper bar stock, nickel strip stock, plastic powder, fiberglass pellets, powdered metal are the principal raw materials used in production.

The various types of metal bar stock are machined into component parts using automatic screw machines. Metal shafts that are produced are sent to the four-stage aqueous cleaner consisting of an alkaline wash tank, two rinse tanks, and a rust inhibitor rinse tank for carbon steel parts. Other parts produced by the screw-machines are machined further and then washed in the four-stage cleaner. Stainless steel and aluminum parts undergo surface treatment after cleaning.

Almost all of the stainless steel parts and all of the aluminum parts undergo a protective surface treatment to prevent corrosion. The stainless steel parts are submerged in a passivating bath, rinsed, dried, and cleaned in an ultrasonic vapor degreaser. Aluminum parts are submerged in a chromium dioxide solution and rinsed.

Laminations, which are used individually in rotor assembly and stacked and fixed together in stator and stepper assemblies, are produced in the plant also. Individual laminates are cut from strip stock in a punch press and then washed in the four-stage washer and heat treated. The laminations are either transferred individually to the rotor assembly area or to spray painting, or are stacked and then held in the place by shrink wrap or by welding. The welded laminates are then sent to painting, and unwelded stacks are transferred to the stator and stepper area.

In the rotor and stator assembly line, individual laminations are pressed onto metal shafts. The resulting rotors and stators are machined, washed in the four-stage cleaner and in an ultrasonic vapor degreaser, and transferred to final assembly. The completed units are tested, the motor housings are wiped clean and stamped with identifying markings, and the finished parts are packaged and shipped.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following techniques to manage and minimize its wastes.

* Distillation units are used to recover usable TF-Freon from contaminated Freon from the plant's vapor degreasers.
* An in-drum waste compactor is used to reduce the volume and disposal cost of paper towel waste.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: electrical rotating devices; four-stage aqueous cleaner; rinse tanks; ultrasonic vapor degreaser; laminations; distillation units; in-drum waste compactor

TITLE: Manufacturer of Gravure-Coated Metalized Paper and Metalized Film.

PLANT BACKGROUND: The plant produces gravure-coated metalized polypropylene and polyester film for use in labeling and wrapping food products. It operates 8,760 hr/yr to produce over 14 million pounds of product annually.

MANUFACTURING PROCESS: The plant's products are manufactured from raw paper and film received in bulk rolls. Other raw materials include water-based and solvent-based coatings mixtures, aluminum wire (for vapor deposition coating), liquid nitrogen, and diluting solvents.

Diluting solvents are received in bulk quantities and stored. The organic-solvent-based coating mixtures are diluted with methyl ethyl ketone (MEK) as required and transported to the pre-coater. Water-based coating mixture is diluted with isopropanol to either the pre-coater or top-coater.

Raw white coated paper is processed in the pre-coater where coating is applied to enhance the gloss of the paper and provide a good surface for aluminum adhesion during later vacuum metalization. Two coatings are applied to the paper, and in some cases, both sides of the paper are coated. One of the three organic-solvent-based coatings or the water-based coating is used for each coating application; the first and second coating applications may or may not use the same coating mixture. Following coating, the paper is dried in the pre-coater oven.

Each coated paper roll from the pre-coater is transported to one of two vacuum metalizers. Rolls of polypropylene and polyester film are processed in a specialized vacuum metalizer. A thin layer of aluminum is deposited on the paper and film through vapor-deposition. About half of the metalized film is cut to specification in the metalizer and sent directly to shipping. The rest of the film is sent to the finishing, rewind, and slitting area of the plant prior to shipping.

The metalized paper is transported to the top-coater where coating is applied to the metalized surface in the same manner that the initial coating was applied in the pre-coater. The top coat acts as a printing primer and provides a clear protective layer. The coated paper is dried in the top-coater oven and sent to the finishing, rewind, and slitting area prior to shipping.

EXISTING WASTE MANAGEMENT PRACTICES: This plant operates an onsite solvent recovery still to recover MEK from solvent wastes. Recovered solvent is used for diluting coating mixtures and clean-up.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: gravure-coated metalized polypropylene and polyester film; water-based and solvent based coating mixtures; diluting solvents; vacuum metalizer; on-site solvent recovery

TITLE: Manufacturer of Paints and Lacquers.

PLANT BACKGROUND: This plant manufactures lacquers and consumer and industrial water-based and solvent-based paints. It operates 4,000 hr/yr to produce approximately 1.5 million gallons of paint and lacquer annually.

MANUFACTURING PROCESS: The raw materials used by this plant include pigments, resins, fillers, plasticizers, dryers, preservatives, solvents, and water. Water-based paints represent about one-third of the total production; the remainder is solvent-based. The production processes for water-based and solvent-based products are very similar; the major distinction between the processes is the use of water or solvent.

Specified amounts of raw materials are prepared for batches of product in the pre-batch area. Those ingredients, other additives, and solvent or water are blended at one of several mixing stations. Pigment dispersion is checked and if it is unacceptable, the mixture is ground in a sand-mill or a pebble-mill. If lacquer is being manufactured, the liquid from the mills is sent to a separate building where additives are added and the resulting mixture is pumped into drums.

For products other than lacquer, the mixture is pumped from the mixing station or from the mills to one of several let-down tanks where additives, tint, resins,and solvent are added. The viscosity, dry gloss, translucency, color, and other physical properties of the product are tested in the laboratory and adjustments are made as needed. The product is pumped from the let-down tanks through filters to an automated filling unit or gravity-fed to drums and tankers.

EXISTING WASTE MANAGEMENT PRACTICES: This plant has implemented the following techniques to manage and minimize its wastes:

* When possible, cleaning solvents are reused in paint formulation.
* Plastic liners are used in steel pails to reduce cleaning wastes.
* Obsolete products and products returned by customers are blended into new products when feasible.
* Plant personnel are evaluating the possible purchase of a distillation unit for the recovery of spent solvents that are currently shipped off-site.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: lacquers; consumer and industrial water-based and solvent-based paints; pigment dispersion; viscosity; dry gloss; translucency; color; physical properties; plastic liners; distillation unit

TITLE: Manufacturer of Surgical Implants

PLANT BACKGROUND: This plant manufactures surgical implants. Nearly four million parts are produced each year during 4,160 hours of operation.

MANUFACTURING PROCESS: Fasteners and plates are manufactured from stainless steel and titanium sheets, rectangles, and round stock.

The first step in the plate manufacturing process is the sanding and cutting to size of stainless steel stock. Computer numerically controlled (CNC) mills are used to mill the sides of the plate, and another mill finishes the top and bottom of the plate. Lathes, drills, broaches, and additional mills are used for further machining operations. Then the parts are placed in one of several vibratory polishers that utilize aluminum oxide chips and water for additional finishing. Sand blasting may be used in place of vibratory polishing for some parts. The final finishing step is electropolishing, which uses an alkaline cleaner, a hot water rinse, a cold water rinse, a phosphoric acid solution, a hot water rinse and hold, electropolishing solution, and deionized water rinse. After the part dries, a logo and serial number are etched chemically onto its surface. Finally, the parts are passivated in a nitric solution, inspected, boxed, and shipped.

Fasteners are manufactured in a separate area of the paint. Cylindrical metal blanks are cut and machined to form a screw head on one end. Centerless grinders are used to shape the head and reduce the outside diameter. Threads are cut into the blanks using mills. The fasteners are polished in the vibratory polishers, electropolished, and passivated. The finished products are inspected, packaged, and shipped.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following techniques to manage and minimize its wastes.

* An aqueous, citric-based cleaner has replaced solvents used for cleaning machined plates prior to polishing.
* Water meters have been installed on all aqueous waste streams that are discharged to the treatment unit to monitor and control water usage.
* Scrap metal is shipped offsite for recycling.
* Centrifuges have seen installed on many of the machines used in fastener fabrication to separate metal chips from the oil-based cutting fluid, thereby extending the fluid's life and reducing waste generation.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: surgical implants; computer numerically controlled (CNC) mills; electropolishing passivation; aqueous, citric based cleaner; centrifuge; metal chips; oil-based cutting fluid

TITLE: Manufacturer of Mountings for Electronic Circuit Components

PLANT BACKGROUND: This plant produces ceramic mountings for electronic circuit components. Approximately 600,000 mountings are produced each year by the plant, which operates 4,160 hr/yr.

MANUFACTURING PROCESS: Several types of mountings or "packages," varying in size and number of ceramic layers and connectors, are manufactured by the plant. The unit operations used to produce the plant's products are described below:

* Ceramic Tape Production

A ceramic slurry is mixed from dry and liquid ingredients and deairated. The slurry is poured into a thin film on a conveyor and cured in an oven. The resulting soft ceramic tape is cut and rolled onto cores. Tape rolls that pass inspection are pressure-and heat-stabilized and then pouched and cut automatically.

* Tungsten Paste Mixing

Tungsten paste is produced from dry and liquid ingredients. Finished paste is poured into small jars for storage until required for production.

* Screening

Ceramic tape that has been cut into sheets is loaded onto a screening machine where the insides of holes that have been punched are coated with tungsten paste. A circuit board pattern is automatically applied and dried in another screening machine. The screened sheets are transferred to a metal press where they receive a dielectric coating as needed to prevent plating in certain areas. Some of the sheets are transferred to the laminating process and then all screens are scored or cut, cured, inspected and transferred to the nickel-plating process.

*Laminating

Those sheets that require laminating are moved through a booth where they are sprayed with adhesive. The individual screens are stacked, indexed, and placed in a press to bond the stacked sheets.

* Nickel Plating

The packages are nickel plated using one of three automated operations-electrolytic, vapor deposition, or electroless. Packages that have been electrolytically nickel plated are transferred to electrolytic gold plating, brazing, or to a sintering furnace and then to electrolytic gold plating. The packages that undergo vapor deposition are transferred to electroless gold plating or to brazing. After electroless nickel plating, packages are transferred to electroless gold-plating.

* Gold Plating

Packages are gold-plated in one of two electroless plating lines or in an electrolytic plating line. After electroless gold plating, packages are taken to brazing or inspected and shipped. Packages from brazing and packages from electrolytic nickel-plating are gold-plated electrolytically, brazed, and shipped.

* Brazing

Whether or not a package is brazed and at what stage it is brazed depends on the product being produced. After brazing, the packages are inspected and returned to one of the gold plating processes.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following techniques to manage and minimize its waste.

* A citric-based cleaning solution is used instead of toluene for clean-up in the screening area.
* Most of the off-specification ceramic tape and cuttings from ceramic tape is recycled onsite.
* Toluene is decanted and reused in the cleaning processes.
* Sodium hydroxide and hydrochloric acid solutions from alkaline cleaning tanks in the plating process are used to adjust wastewater pH levels in the onsite wastewater treatment system.
* Rags wetted with citric-based cleaning solution are washed in-house and reused.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Since one or more of these approaches to waste reduction may increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

* Compact the contaminated nickel plating solution filters prior to disposal to reduce the volume of space they occupy and the associated removal cost.
* Install a natural gas-fired dry-out oven to reduce the amount of water contained in the sludge from the onsite wastewater treatment plant.
* Automate the measuring and delivery process of solvents to the mixing chambers in the tape production area to reduce evaporative losses.
* Recover evaporated solvents from tape production, tungsten paste mixing, and clean-up for reuse.
* Substitute a nonhazardous cleaner for the solvent cleaners used in the tape production and tungsten paste mixing lines.
* Substitute a nonhazardous cleaner for 1,1,1-trichloroethane used for clean-up in the screening area.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: ceramic mountings; citric-based cleaning solution; nature gas-fired dry-out oven; tape production; tungsten paste mixing; 1,1,1 trichloroethane; laminating; brazing; screening; gold/nickel plating

TITLE: Manufacturer of Microelectronic Components

PLANT BACKGROUND: This plant manufactures monolith and hybrid amplifiers and integrated circuit assemblies. Over 100,000 assemblies are produced annually by the plant during approximately 5,000 hours of operation.

MANUFACTURING PROCESS: Thin-film circuitry is generated on sheet-alumina substrates using photolithography for pattern generation and vacuum-chamber vapor deposition to form circuit components. Photoresist is applied to the substrate, dried, exposed to ultra-violet light, and developed to leave polymerized material on areas to be protected during subsequent vapor deposition. Remaining photoresist is removed with a resist stripper. These process may be repeated several times to add circuit elements in a sequential manner. Resistors are trimmed to specific values using laser machines.

Assembly of the products involves attaching integrated circuits and other components to the ceramic substrates. Much of the process is automated. The resulting products are tested, inspected, packaged, and shipped.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following techniques to manage and minimize its waste.

* Waste acetone from the stagnant bath for photoresist removal is reused in the ultrasonic acid bath in the same line.
* Waste tri-iodine stripping solution is shipped offsite for gold recovery.
* Water-based solder fluxes are replacing solvent-based solder fluxes.
* A close-loop rinse is used for cleaning following stripping and etching.
* Acetone and isopropyl alcohol baths and waste drums are kept covered to reduce evaporation.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Since one or more of these approaches to waste reduction may increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

* Reuse the laser cooling water instead of sewering it after use.
* Use deionized water and a hot air dryer to replace acetone and isopropyl alcohol used for drying wafers after initial cleaning.
* Continue to use the tri-iodine gold stripper for a longer period of time before disposal.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: amplifiers; integrated circuit assemblies; ceramic substrates; photoresist removal; waste tr-iodine; water-based solder fluxes; laser cooling water; vapor deposition

TITLE: Manufacturer of Coated Parts

PLANT BACKGROUND: This plant produces specially coated aluminum, steel, and plastic parts. It operates 2,210 hr/yr to produce approximately 1 million units.

MANUFACTURING PROCESS: The plant operates as a job shop to apply special purpose surface coatings to customer-supplied parts. Coatings applied to the parts include chromate-conversion, zinc phosphating, and organic coatings.

Parts that receive conversion coatings are first cleaned in a heated alkaline bath, rinsed, desmutted, and rinsed again. Then the parts are immersed in a heated chromic acid solution, rinsed again, and air dried.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following to manage and minimize its wastes.

* High volume, low pressure paint guns are used for most painting to reduce overspray.
* Operations use care in raising parts bins slowly from process solutions and allow sufficient drainage time to reduce drag-out.
* Some solvents are recovered on-site for reuse.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: coated aluminum, steel, plastic parts; chromate-conversion coating; zinc phosphating coating; organic coatings; high volume, low pressure paint; on-site solvent recovery

TITLE: Manufacturer of Finished Metal and Plastic Parts

PLANT BACKGROUND: This plant is a job shop that applies coatings to metal and plastic components supplied by its customers. It operates 4,940 hr/yr to produce approximately 234,000 sq ft of product annually.

MANUFACTURING PROCESS: Prefabricated aluminum, steel, and plastic parts are supplied to the plant by its customers who specify the coating or paint that is to be applied. The plant performs several different coating operations, but the ones that generate consistent and appreciable amounts of waste are anodizing of aluminum parts, chromating of aluminum parts, painting of plastic and metal parts.

* Anodizing: Aluminum parts to be anodized are first immersed in a caustic solution and then an etching solution to remove surface contaminants. Smut that remains on the parts after etching is removed using an acidic deoxidizing solution. A surface oxide layer is then formed on the parts in an aqueous electrolytic bath that contains sulfuric acid. The anodized parts are then dyed one of five colors or left undyed. Next, an aqueous nickel fluoride solution is used to seal the oxide layer. The last step is rinsing of the finished parts. The anodized parts are then assembled if necessary, packaged, and shipped back to the customer.

* Chromating: Chromate conversion coatings are applied to aluminum parts by first immersing the parts in a series of aqueous solutions for cleaning, etching, and acidic deoxidizing. The parts are then immersed in the chromate conversion solution and rinsed. The finished parts are then painted if required, inspected, assembled if necessary, package, and shipped back to the customer.

* Painting: Parts that require painting are painted in one of three spray booths. Water-based, solvent-based, and powder coatings are used by the plant according to the customer's specifications. Special tooling supplied by the customer is used to mount the parts to be painted. After the coating has been applied, the parts are placed in an oven for curing and drying. The completed parts are inspected, packaged, and shipped back to the customer.

EXISTING WASTE MANAGEMENT OPPORTUNITIES: This plant already has implemented the following techniques to manage and minimize its waste.

* Flow reducers have been installed on all flowing rinses in the anodizing and chromating lines.
* A solvent distillation unit is used to recover paint-related solvents which are then reused by the plant.
* The use of water-based instead of solvent-based paints is significant and is increasing. Plant personnel encourage customers to specify water-based and powder-based paints.
* Operators use care in raising parts racks slowly from the process solutions and allowing sufficient drainage time to reduce drag-out in the anodizing and chromating lines.
* Water used to cool Freon in the chillers associated with the anodizing tanks is reused as rinse water.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Since one or more of these approaches to waste reduction may increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

- Modify the onsite solvent distillation unit in order to raise the temperature and the recovery factor.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: metal and plastic components; coatings; anodizing; chromating; painting; flow reducers; solvent distillation unit; water-based paints; sufficient drainage time; freon; recovery factor

TITLE: Manufacturer of Battery Separators

PLANT BACKGROUND: This plant manufactures two types of automotive battery separators. It operates approximately 8,400 hr/yr to produce almost 3.5 billion square feet of polyethylene/silica separators and over 2 billion vinyl rib separators annually.

MANUFACTURING PROCESS: Automotive battery separators, which are thin sheets placed between battery electrodes, to keep them from shorting out, are manufactured by this plant. The production processes for the two types of separators manufactured-polyethylene/silica sheet and vinyl rib-will be described here.

* Polyethylene/Silica Sheet:
  Polyethylene/silica sheet is manufactured from a mixture of high density polyethylene, ultrahigh molecular weight polyethylene, silica, oil, and other ingredients. The raw materials are blended together and the resulting mixture is extruded through a die bar into a sheet and calendared. The oil, which prevents the silica from damaging the extruder and provides porosity to the product, is then removed by countercurrent extraction with TCE. After oil removal, the sheet passes through a drying oven for TCE removal and enters a bath where a wetting agent is added to change the electrical properties of the sheet. The sheet is then dried again for water and further TCE removal and is inspected, wound onto a roll, and slit. Recovered oil and TCE are reused by the plant.

* Vinyl Rib Separators:
  A latex batch containing latex, saline, water, and other ingredients is mixed in two steps and placed in a dip tank. Plastisol, which is composed of diethylhexyl phthalate, polyvinyl chloride, mineral spirits, and other ingredients, is mixed separately for use in extrusion through the rib dip bar.

In order to produce the vinyl rib separators, fiberglass sheet paper is dipped into the dip tank, squeezed between rollers to remove excess latex, and then passed under the rib die bar where plastisol is extruded onto the sheet to form the ribs. The resulting product sheet is dried in an oven, cut into squares, inspected, and packaged.

EXISTING WASTE MANAGEMENT PRACTICE: This plant already has implemented the following techniques to manage and minimize its waste.

* Waste fiberglass paper from vinyl rib production is used to adsorb spills from polyethylene/silica sheet production thus reducing the quantity of adsorbents purchased.
* Trichloroethylene fugitive emissions are reduced as a result of the extraction pans, turnaround, drier, wetting agent bath, and water drier being welded together.
* Disposable cotton wound cartridge filters are being replaced by reusable metal mesh strainers on the still feed lines.
* Recovered materials such as oil and TCE are reused extensively onsite.
* Equipment to regrind blacksheet trim for reuse in the polyethylene/silica sheet production line has been purchased.
* Roll cores from the fiberglass sheet used in the vinyl rib production line is returned to the supplier for reuse.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Since one or more of these approaches to waste reduction may increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

* Identify a suitable alternative for trichloroethylene currently used for oil removal.
* Identify an alternative oil for use in the process, thereby making it possible to use a different solvent for extraction.
* Grind waste black sheet for reuse onsite.
* Replace the steam stripper used for oil recovery on one of the process lines with a newer, more efficient unit.
* Install a backup centrifuge to take the place of the primary centrifuge when it is not working.
* Regenerate the carbon beds with nitrogen instead of steam in order to eliminate the generation of wastewater containing TCE.
* Recover dactyl phthalate from stack gases prior to incineration by carbon bed adsorption and condensation.
* Reuse empty gaylords internally and/or obtain shipments received in paper bags with shipments in returnable bulk bags.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: automotive battery separators; polyethylene/silica separators; vinyl rib separators; waste fiberglass paper; trichloroethylene fugitive emissions; cartridge filters; regrind blacksheet trim; steam stripper; backup centrifuge; dactyl phthalate

TITLE: Manufacturer of Folding Paperboard Cartons

PLANT BACKGROUND: This plant manufactures folding paperboard cartons. It operates approximately 2,200 hr/yr to produce about 1,200 tons of cartons annually.

MANUFACTURING PROCESS: Paperboard rolls of various gauges are cut to specific sheet sizes in the sheeter machine. If required, the paper sheets are sent to the hydraulic cutter for trimming to smaller sheet sizes. The sheets are stacked on pallets and assigned a labeling code in preparation for printing.

For the past several years, the plant has used its six-color press for printing exclusively. Two other presses a two-color and a three-color-are also available. Printing plates are developed onsite using a recently installed photolithographic process. Printing plates are attached to five of the six press cylinders. Each cylinder transfers a different color to each sheet as it passes through the press. The sixth and final cylinder is used exclusively to apply a clear aqueous coating to the sheet, which gives the printed sheet a glossy appearance. Printed sheets are attached at the end of the press to await die cutting.

The printed sheets are cut into carton sheets by one of the die cutters. The die cutter feeds the sheet through, cuts the desired carton pattern, applies the fold impression. Die patterns used by the die cutters are produced onsite from metal strips and wood arranged on polywood slabs. Excess strips of paper are removed from cartons manually after die cutting in the striping area. The stripped sheets are attached on pallets and sent to either windowing or folding and gluing.

The large and small windower machines are used to apply a clear plastic film to cover carton openings. A glue wheel is used to apply a glue pattern on the carton to affix the film. Cartons are sent to one of three folding and gluing machines in which the carton sides are glued together. Glue is applied using a glue pads in two of the machines and automatically in the third machine. Completed cartons are boxed and stored to await shipping.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following techniques to manage and minimize its wastes.

* Ink is collected from the color presses at the end of the day, returned to its proper container, and stored for reuse.
* Waste film from the photolithographic process is collected and shipped offsite for recycling.
* Waste paperboard instead of new paperboard is fed through the printing press at start-up until the printing quality meets specifications to avoid the generation of additional waste paperboard.
* Printed and non-printed waste paperboard is baled and shipped offsite for recycling.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Since one or more of these approaches to waste reduction may increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

* Install a silver recovery unit onsite to recover dissolved silver from spent photographic fixer and wash water.

* Improve the existing paperboard recycling program. Suggested improvements include standardizing the type of board manufactured; improving the sorting of various types of waste board; automating the collection and baling operations; reducing the size of waste bales; and moving the waste board storage and baling unit outdoors.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: paperboard cartons; printing plates; die cutter; windower machines; photolithographic process; silver recovery unit; waste paperboard recycling

TITLE: Manufacturer of Pharmaceuticals

PLANT BACKGROUND: This plant manufactures intermediates for pharmaceuticals and other miscellaneous chemicals. Over six million pounds of product are produced annually during 8,640 hr/yr of operation.

MANUFACTURING PROCESS: Production is performed by the plant in batches and is structured into campaigns. The required raw materials and pre-processed materials are received from a sister plant. The production of the pharmaceuticals requires several reaction and purifying steps that are combined to make up a single batch. Batches isolate either intermediate or final products. Several intermediates may be required to get to the final product stage.

EXISTING WASTE MANAGEMENT PRACTICES: This plant has implemented the following techniques to manage and minimize its wastes.

* The Responsible Care program of the Chemical Manufacture's Association is used as the plant's waste minimization vehicle. The program emphasizes pollution prevention at the source rather than end-of-pipe solutions.
* An average of 95% of solvents are reused by the plant.
* Clean, used solvents are incinerated onsite to produce required steam, thereby reducing fuel consumption.
* Off-specification batch materials are reused.
* Enclosed centrifuges are used for dedicated processes to reduce air emissions volatile organic compounds from solvents.
* A policy has been implemented for the chemists to eliminate new production processes that require metallic compounds or chlorinated solvents.
* A site reduction plan for air emissions that includes a mass spectrometer used to monitor air emissions throughout the plant has been implemented.
* Since initial site visit by the WMAC assessment team, some of the production steps for one of the products have been revised thereby reducing the generation rate of waste acetone dramatically.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Since one or more of these approaches to waste reduction may increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

* Reuse the water from the onsite wastewater treatment plant as make-up water for the cooling tower.
* Install suitable storage tanks, piping, and a pump to permit onsite reuse of waste hexane.
* Install a sludge dryer to remove water from the wastewater treatment sludge.
* Extend the life of the solvents used for tank cleaning by implementing staged cleaning.
* Install a small solvent recovery unit to distill small volumes of waste solvent for reuse onsite.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268, (513) 569-7578

KEY WORDS: intermediates; batches; solvent reuse; solvent incineration; enclosed centrifuges; mass spectrometer; sludge dryer; staged cleaning

TITLE: Manufacturer of Food Service Equipment

PLANT BACKGROUND: This plant manufactures commercial food service equipment, storage bins, cabinets, and other miscellaneous sheet metal products. Sixty employees produce one-half million pounds of stainless steel and painted steel products during approximately 2,200 operating hours annually.

MANUFACTURING PROCESS:

* Specialty Sheet Metal Fabrication: Food service equipment, counter tops, case work, and other products required on a job-shop basis are produced in the custom shop area of the plant. Raw materials used include stainless steel, mild steel, aluminum, and copper and brass. Stainless and mild steel arrive at the plant in sheets of precut blanks that are trimmed to size using hydraulic shears. Operations performed include plasma cutting, forming, bending, custom welding, polishing, finishing, and assembly.
* Ice Storage Equipment Fabrication: The other production activity at this plant is the fabrication of ice storage equipment. Trimmed sheet metal received from the shearing operation is cut, formed, welded, finished, prepared for painting, painted, and insulated with polyurethane foam.

EXISTING WASTE MANAGEMENT PRACTICES: This plant already has implemented the following techniques to manage and minimize its wastes.

* Scrap stainless steel is collected and sold to a scrap metal dealer for reuse.
* A citrus-based cleaner is used instead of solvents in some wipe-down cleaning operations.
* Most of the ice storage products are coated using powder coating technology rather than conventional painting.
* The nozzle of the foam insulation application system is cleaned with ethylene glycol rather than methylene chloride.

WASTE MINIMIZATION OPPORTUNITIES: The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. It should be noted that the economic savings of the minimization opportunity, in most cases, result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that may result when the opportunities are implemented in a package.

Since one or more of these approaches to waste reduction may increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

* Install a solvent recovery unit to recover waste toluene generated during parts cleaning and wipe-down in the painting area.
* Install an enclosed spray gun washer in order to reduce solvent air emissions associated with paint gun cleaning.

PRINCIPAL INVESTIGATOR: University City Science Center

EPA PROJECT OFFICER: Emma Lou George
U.S. EPA, RREL
Cincinnati, Ohio 45268
(513) 569-7578

KEY WORDS: sheet metal fabrication; ice storage equipment fabrication; citru-based cleaner; powder coating; foam insulation application system; solvent recovery unit; enclosed spray gun washer

INDEX

☆U.S. GOVERNMENT PRINTING OFFICE: 1995 - 650-006/00248

United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

Official Business
Penalty for Private Use
$300

EPA/600/R-95/036

Please make all necessary changes on the below label, detach or copy, and return to the address in the upper left-hand corner.

If you do not wish to receive these reports CHECK HERE ☐; detach, or copy this cover, and return to the address in the upper left-hand corner.

BULK RATE
POSTAGE & FEES PAID
EPA
PERMIT No. G-35